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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

REPORT OF THE

ALLEGHENY FOREST EXPERIMENT STATION

January 1 to December 31, 1931

PLAN OF WORK

January 1, 1932 to June 30, 1933

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STATION NEEDS

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ALLEGHENY FOREST EXPERIMENT STATION

Permanent Staff

Forest Service

R. D. Forbes, Director
A. B. Hatch, Assistant Silviculturist
A. F. Hough, Assistant Silviculturist
H. F. Morey, Junior Forester (transferred November 1 to Northeastern Station)
G. L. Schnur, Assistant Silviculturist
O. M. Wood, Assistant Silviculturist

Margaret R. Burn, Junior Clerk (appointed October 1, 1931)
Hazel V. Loose, Statistical Clerk
Julia Pruitt Schnur, Junior Clerk (resigned October 1, 1931)
C. Eunice Skamser, Senior Clerk

Bureau of Plant Industry (Forest Pathology)

K. D. Doak, Assistant Pathologist
L. W. R. Jackson, Assistant Pathologist

Temporary Assistants

C. X. Grano
Max A. Melick
Togo McKeithen
H. E. Pilmer
Dr. L. E. Yocum, University of Pennsylvania

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1931

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E. O. Ehrhart, Armstrong Forest Company, Johnsonburg, Pennsylvania.
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Dr. O. E. Jennings, Curator of Botany, Carnegie Museum, Pittsburgh, Pennsylvania.
Henry W. Leeds, Chalfonte-Haddon Hall, Atlantic City, New Jersey.
Louis C. Madeira III, Madeira Hill & Company, 260 South Broad Street, Philadelphia, Pennsylvania.
A. J. Musser, General Manager, Clearfield Bituminous Coal Corporation, Indiana, Pennsylvania.
E. C. M. Richards, Box 525, Media, Pennsylvania.
Lewis E. Staley, Secretary, Department of Forests and Waters, Harrisburg, Pennsylvania.
DeCourcy W. Thom, Maryland Trust Building, Baltimore, Maryland.
Captain Alexander R. Wheeler, Wheeler & Dusenbury Lumber Company, Endeavor, Pennsylvania.
Ezra B. Whitman, Baltimore Trust Building, Baltimore, Maryland.
C. P. Wilber, State Forester, Trenton, New Jersey.

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REPORT OF THE ALLEGHENY FOREST EXPERIMENT STATION*

I. Work of the Calendar Year 1931

The chief accomplishments of the Allegheny Station in 1931 were:

A field survey clearly revealed mycorrhiza as a universal phenomenon in the forests of the Station territory, and furnished large collections of mycorrhiza for laboratory study. Laboratories for this work were equipped in Philadelphia. The Boyce Thompson Institute of Yonkers, New York, provided unique facilities for developing certain methods of laboratory study.

A cooperative study of mine props contained in hardwood trees of given dimensions resulted in publication, by the Pennsylvania Agricultural Experiment Station, of Bulletin 269, "The Measurement of Mine Props - Linear Foot, Top Diameter, Weight and Volume Tables."

The newly-established Kane (Pennsylvania) Experimental Forest was made accessible by road improvements; a resident caretaker's house and a field laboratory, with gas, water, and sewerage systems, were built; and the boundary of the Forest was surveyed and thoroughly marked on the ground.

Examination of the root systems of important species in south Jersey, and other intensive studies, suggested some causes of the universal scarcity of seedlings, and opened promising avenues of attack on the problems of natural reproduction.

Field studies were begun of root rot of sprout oaks not subject to fire.

Available data were compiled, by States and forest types, on the present stand of timber in the Station territory, and its rate of growth.

ADMINISTRATION

Personnel

An administrative order, part of the program of retrenchment made necessary by present economic conditions, cut $750 from the Station's budget for the fiscal year 1931-32, and necessitated

*Maintained in cooperation with the University of Pennsylvania. The territory of the Station includes the States of Delaware, Maryland, New Jersey, and Pennsylvania.

a reduction in the permanent Forest Service staff to five men. Junior Forester Morey was transferred on October 1 to the Northeastern Station. In Morey the Station has lost a very hard-working and alert man. Miss M. R. Burn took the place of second clerk left vacant by the resignation of Mrs. Schnur.

Advisory Council

The Council met at Atlantic City on January 10 and 11, to consider the proposed program of the Station. The research work under way by the Maryland Forest Service and the Pennsylvania State College was also described by the representatives of those organizations. Proposals to expand the Station program to include (1) a thorough-going study of the effect of forest and other natural vegetation on erosion and the flow of streams, and (2) an adequate study of fire damage, met with much interest and full approval. The Council voted to request the National Forest Reservation Commission to consider the purchase of a sample of the virgin timber on East Tionesta Creek, Allegheny National Forest, for scientific purposes.

Emergency appropriations

About $16,000 was allotted to the Experiment Station from emergency funds for unemployment relief, and the entire sum was spent in the development of the Kane Experimental Forest. Details of its expenditure are given under the description of the project dealing with the natural reproduction and methods of cutting of Allegheny hardwoods.

Compilation of economic data

The Station was called upon to compile a large amount of economic data for the states of Pennsylvania and New Jersey, as part of the Forest Service contribution to the report of the Timber Conservation Board. The volume of information available on the forest stands of the state of Pennsylvania justified the Station in taking a large amount of time to adapt it for inclusion in the Forest Service report. These data were obtained by the Department of Forests and Waters in 1924-6. Some excellent information was obtained verbally from the New Jersey authorities also. Figures on growth and yield were laboriously compiled from many sources. The final report, as rendered by the Director, covered more than 100 pages. District Inspector Gordon Backus, of the Branch of Public Relations, compiled similar material for Delaware and Maryland.

Cooperation and public relations

During the year the University of Pennsylvania, which had already furnished us with an adequate office building, and one laboratory on the first floor of Macfarlane Hall, made a second laboratory available to us in the basement of the same building. The Station installed a ventilating fan, and a new waterproof floor. The equipment now housed in our two laboratories in Macfarlane Hall has a value of about $7,500. Of this the Forest Service has furnished about $3,000. The University has made a most satisfactory increase in the greenhouse space available to us.

The Boyce Thompson Institute of Botanical Research, at Yonkers, New York, has very generously furnished unique laboratory and greenhouse facilities for the mycorrhiza experiments later described. All this is without charge to us.

Among the visitors to the Experiment Station during the year has been Dr. M. C. Rayner of England. Dr. Rayner is among the best known students of mycorrhiza, and her enthusiastic interest in our forest mycorrhiza project has been stimulating.

Professor H. J. Lutz of the Pennsylvania State College made the Camp Ockanickon field house his headquarters during summer field work in the Plains of southern New Jersey.

The Station has contributed speakers to the programs of the following: Graduate Botanical Club, University of Pennsylvania; Botany Seminar, University of Pennsylvania; Philadelphia Botanical Club; Pennsylvania Forestry Association; Botanical Society of Pennsylvania; The Retail Lumber Dealers' Association of Western Pennsylvania; and the Allegheny Section, Society of American Foresters.

The Director was a member of the type committee of the Society of American Foresters, and served as chairman of the Allegheny Section during 1931. Mr. Jackson was chairman of the Section committee on forest insects and disease, and Mr. Hough a member of the committee on forest types.

RESEARCH IN SILVICS

The effort of the Experiment Station, measured in terms of personnel and expenditures, has been concentrated on five projects. A small amount of work has been done on three additional projects. The basis for selecting these particular lines of work out of the many which even a casual acquaintance with the Station territory will suggest, is as follows:

Management (formerly methods of cutting and natural reproduction)*, Allegheny hardwoods. About one-quarter of the forest area of the states of Pennsylvania, New Jersey, Delaware, and Maryland is included in this forest type, which is a variant of the beech-birch-maple type, and at present is the only important source of lumber in the Station territory. Approximately 90 per cent of the one National Forest in that territory is Allegheny hardwoods; as a Federal agency, the Station owes its first obligation of service to the National Forests. Comparatively little research work has been done in the type. The State of Pennsylvania, for example, has concentrated its research work in the oak types, where more than 80 per cent of the State Forests lie.

Protection, mycorrhiza (formerly mycorrhiza of forest trees). As revealed by the systematic survey of the Station territory made in 1931, mycorrhiza are an almost universal phenomenon; the roots of practically every species of tree and woody shrub in the Station territory show fungal association in greater or less degree. Anything which affects so vital a part of trees as the roots, from extreme youth to old age, is on the face of it extremely important. Should mycorrhiza prove to be beneficial to the higher plants, knowledge of them may have extremely practical applications to the science and art of forestry.

Management (formerly natural reproduction), Coastal Plain. About 1,500,000 acres of nearly continuous forests in southern New Jersey, lying closer to great centers of population than any similar area of forest land in the United States, have apparently degenerated seriously under man's abuse. Seedling growth, except of pine, is rare; the hardwood sprouts are widely spaced and stagnate in growth at 40 or 50 years. Rehabilitation of the forests as producers of wood, as centers of recreation, and perhaps as regulators of extremely valuable streamflow, is not only a challenging problem, but offers a field for scientific study geographically convenient to the Station headquarters in Philadelphia.

Mensuration (formerly growth and yield), oaks. Oaks are the predominant tree species of 60 per cent of the forests of the Station territory. A detailed knowledge of their growth, and that of the species commonly associated with them, is essential to putting timber growing on an economic basis. It is impossible to determine what may justifiably be spent in protection of forest land against fire, or the returns which may be expected from the practice of forestry, without a knowledge of the volume of forest products which is contained in trees and stands.

* Designation used in preceding Station report.

Mensuration (formerly growth and yield) of loblolly pine. This pine is the most valuable species of tree growing on approximately 1,400,000 acres of forest land on the eastern shore of Maryland and in Delaware, a region where intensive forest management is made possible by the heavy demand for forest products of all kinds. The same need exists for studies of volume and yield as in the case of the oaks.

Forestation, planting (formerly planting, south Jersey). Because of the expense, planting is a less promising means of rehabilitating the forests of south Jersey than is natural reproduction. For this reason, and because work in this field is being done by the New Jersey Forest Service, the investigation is a minor one on the Station program. The plantations at the Camp Ockanicken Branch afford additional material for studying the factors affecting the survival of all reproduction, whether planted or natural.

Types. This study, as conducted at the Allegheny Station, is a means to an end rather than an end in itself. Enough progress has been made in it so that the main forest types with which the Station has to deal are fairly closely defined. It is therefore distinctly a minor project, and for the present no additional work need be done on it.

Protection, fire (formerly fire damage). This project is classed as a minor one on the Station program only because personnel and funds are lacking to pursue it adequately. All orderly plans for the protection of forests against fire must rest ultimately on the values at stake. A knowledge of the damage done by fires to tree growth, to the soil, and to indirect forest values, is essential. This project should be given a place of great importance on the Station program as soon as possible.

A detailed account of the work done on the several projects follows.

Management, Allegheny hardwoods.

(Assistant Silviculturist Hough in charge; Junior Forester Morey)

East Tionesta virgin timber

A revised estimate of the acreage of original, or only slightly modified, forest growth on East Tionesta Creek, Allegheny National Forest, shows it to be 6000. Few, if any, new areas were logged in 1931, owing to the continued depression of the lumber market. The intensive surveys made in this tract in 1930 were directed, first, toward obtaining a record of the natural conditions before the opportunity should be forever lost, and second, toward selecting one or more lots suitable for permanent preservation in their original condition. Because of the concentration of the Station's resources for this project on the Kane Experimental Forest, no additional field work was done on East Tionesta Creek during 1931.

Office analysis of the 1930 tenth-acre tallies had divided them into three categories, based on topography but reflected in composition: Plateau, 397 tenth-acre plots; Middle slope, 153 tenth-acre plots; and Lower slope, 31 tenth-acre plots. For each category summaries, by species, have been made of abundance and frequency, size classes, and basal area of living trees; dead and windthrown trees; reproduction; and lesser vegetation. From these it will be possible to compare this area with Hearts Content and other virgin areas of which the Station has record and form a clearer picture of the Allegheny hardwood type species relationships, amount and methods of reproduction, and influence of windthrow, topography, and certain biotic agencies, such as porcupines, on species composition.

A map of the greater part of the tract has been prepared, showing natural features and the position of the 1930 transects.

Purchase of any part of this timber was disapproved by the Forester, because of the small sums available for national forest purchase, and the abundant offers of less expensive forest land. An illustrated statement was therefore prepared, for use in interesting private individuals or organizations in purchase of a tract and its donation to the Federal government. This statement points out the great scientific value of the area, and the lack of virgin timber, dedicated to scientific purposes, in other public ownership.

Little Arnot plots

The customary re-count was made of the reproduction coming into the three plots cut over according to different methods in 1928-30.

Kane Experimental Forest

Work on the Kane Forest during 1931 was not research, but an indispensable preliminary to it.

A site for the headquarters of the Forest was selected near the middle of the tract early in 1931, and emergency unemployment relief funds were used to gravel four miles of the township road connecting the headquarters with the nearest hard road to Kane, and to construct two miles of excellent dirt road from Dahoga to the headquarters. Officers of the Allegheny National Forest cooperated extensively in the road building. Two five-room buildings were erected, also from unemployment relief funds. One will house the resident superintendent of the tract whom we hope shortly to appoint, and the other will serve as field laboratory, office, and quarters for visiting members of the staff. A drilled well provides abundant water; a sewerage system has been built; natural gas is piped from a commercial line crossing the tract; and an electric generation system has been installed. The whole development provides very satisfactory facilities for conducting research on this area.

A boundary survey, using transit and tape, was completed. Elevations along the boundary were carried from a U. S. G. S. bench mark near Dahoga, using the double Abney level method, and contours were plotted on a base map using a 20 foot contour interval. The boundary line was swamped out, posted with metal signs, and paint-blazed. Cruise stakes, of 1½ inch iron pipe painted white, were set at 10 chain intervals due west of the point of beginning, on both north and south boundaries. These stakes will be used to start from and to check on, when strips are run to gridiron the tract for an inventory of the timber; they will also serve as points to which to tie permanent sample plots in the future.

Extensive surveys

Analysis of the data obtained in the 1929 extensive survey of the beech-birch-maple type (Allegheny hardwoods) in northern Pennsylvania, has been almost completely halted by emergency jobs placed upon the staff.

Protection, mycorrhiza.

(Mr. Hatch, Forest Service, and Dr. Doak, Bureau of Plant Industry.)

This is a joint project, conducted by the Forest Service and the Bureau of Plant Industry. Early in 1931 it was decided to place major emphasis, during the first field season, on a field survey. The survey, for which Dr. Doak was chiefly responsible, was to determine for the Allegheny region the amount of mycorrhiza on forest trees in stands, nurseries, and plantations; species of fungi producing mycorrhiza; the effect of moisture, fire, humus types, soil type, and soil acidity on mycorrhiza prevalence; and the effect of common nursery practices on mycorrhiza formation.

The survey revealed that all species of forest trees growing in stands possess mycorrhiza of some form. The conifers were all found with ectotrophic mycorrhiza while hardwoods showed constant differences depending upon the species. Tulip poplar (Liriodendron tulipifera) and all species of maple showed endotrophic or internally-developed mycorrhiza. The others were found with ectotrophic forms, of types similar to that prevalent in the conifers. Hemlock was the only tree species showing both types in the same roots and this condition was not found in every locality studied or throughout the entire root system. In nurseries and plantations mycorrhiza were always present and the types resembled those occurring on the same species in natural stands. Poorly developed mycorrhiza and pseudo-mycorrhiza occurred more abundantly in nurseries, but were also found in natural stands having a small amount of humus. The microscopic structure of the various types was compared, and specimens and records were preserved for later comparison with the mycorrhiza produced in pure cultures.

The effects of soil acidity on mycorrhiza were not outstanding in any of the locations studied. True mycorrhiza were in general better developed in the humus layers, and in surface soil, which ranged from pH 4.02 to 5.40. In all cases the short roots not formed into true mycorrhiza occurred as various types of pseudo-mycorrhiza which involves fungus infection lacking the typical mycorrhizal structures. Detailed microscopic examination will be made of both types in order to set out the limitations and exact nature of each. Although they were readily distinguished macroscopically for a general estimate of the prevalence of each, the possibility that soil and other environmental conditions may cause true mycorrhizal fungi to form the pseudo type was recognized. Locations lacking surface accumulation of any humus type showed true mycorrhiza in the upper soil, but not as abundantly as in humus. Burned areas were in this category, although complete destruction of the surface humus deposits did not prevent mycorrhiza development in the upper soil.

The survey yielded collections of mycorrhiza for comparison with later pure culture types and authentic fungus cultures from known sporophores. The following fungi, suspected of some connection with mycorrhiza or in a few cases found in direct connection with them, were cultured from sporophores: Boletus bicolor, B. eximus, B. limatulus, B. granulatus, B. subluteus, B. pallidus, B. brevipes, B. felleus, Clitopilus abortivus, Amanita muscaria, Cantharellus cibarius, Boletus chrysenteron, Lycoperdon 84, L. (Westtown -2), Clitocybe laccata, Tricholoma personatum, Rhizopogon parasiticus, Scleroderma 74 (S. vulgare), Lycoperdon eximum, L. pulcherinum, L. gemmatum, Psalliota campestris, Omphallia gracilina, Amanitopsis vaginata, Cortinarius lilacinus, C. flavifolius, Boletinus porosus, B. pictis, Cortinarius elegantioides, Boletus ornatipes, B. chromapes, Gomphidius maculatus, Psilocybe sp. -, Collybia dryophylla. Three cultures were also made directly from mycorrhiza, to be designated in all future work as Knollen taeda (F.P.M.-1), 53 K Black (F.P.M.-2), and Berlin Black 2 A (F.P.M.-3).

Management, Coastal Plain

(Assistant Silviculturist Wood in charge;
Dr. L. E. Yocum)

Although seedlings of all of the pines are fairly abundant in the oak-pine forests of the New Jersey coastal plain, seedling hardwoods are quite rare; an intensive survey of the 342 acres in the branch forest at Camp Ockanickon indicated that perhaps as high as 99 per cent of the oaks are of sprout origin.

Seed productivity, chestnut oak.

The Station's first investigations at Camp Ockanickon were made on the theory that lack of seed production, at least up to the age when the oak stands are commonly cut clean for fuel, accounted for the absence of seedlings. To test this theory a study was made of the seed production of chestnut oak, the species having the greatest volume for the tract as a whole.

In 1928, 1929, and 1930, an estimate of the seed produced by 78 trees was made by counting the cups on 20 square feet of ground surface under the crown of each. In 1930 several smaller

trees were added to this series, and total cup counts were made for these and a few larger trees. Production of seed was consistently high for some individuals and low for others, but on the whole seemed ample for satisfactory seedling reproduction. The seed crop in 1931 was very scanty, however, and counts were not worth making except for a few trees. Many which bore abundant seed in 1930 bore absolutely none in 1931; one tree which bore 933 acorns in 1930 bore only 34 in 1931.

The failure of one seed crop out of four is still an inadequate explanation of the scarcity of seedling chestnut oak. Other factors which may be involved are destruction of the seed and seedlings by fungi, insects, birds, and animals; unfavorable seed bed conditions, resulting in poor germination, and the killing or continued stunting of seedlings by deficient soil moisture or other unfavorable soil conditions, severe weather, insufficient light, disease, insects, animals, etc.

Destruction of seed by fungi, insects, birds, and animals.

Although moldy acorns are common on the ground, no fungi have been observed to attack uninjured acorns on the tree. Insects destroy many acorns of the black oak group at Camp Ockanickon, but rarely those of chestnut oak. However, in 1931 a few of the latter acorns were found split, possibly by insects, when removed from the tree; these were planted, and the effect on germination will be studied.

Animals, and perhaps birds, destroy a great many chestnut oak acorns. For example, the 1928 chestnut oak germination plot, which originally contained 187 germinating acorns, was found to contain but 12 seed or seedlings in the spring of 1929. Squirrels were important, but probably not the only, destroyers of these acorns.

Two seed traps, aggregating 1400 square feet, were placed under chestnut oaks in the fall of 1930, but were made non-effective during the winter through vandalism. The wire was torn from the traps, thus admitting the rodents. All seed was destroyed in one trap and all but a single acorn in the other.

A few 1931 acorns were found which had had their pointed or radicle end bitten off by gray squirrels. These were planted in seed beds screened against rodents, and the effect of this type of damage on subsequent germination will be noted in 1932.

In this and other experiments a total of 1147 acorns were planted under screens in 1931. Some of these were destroyed soon after planting because it had been believed that a 1-inch mesh wire would exclude all the rodents; it was found necessary to put ½-inch mesh wire screens on all the beds.

A bed was prepared which had no rodent screen. The acorns in half the bed were coated with red lead and in the other half with a crow-repellent known as "Crotox", a creosote preparation. A certain number of the treated acorns were left on the surface. These were undisturbed as long as the coating remained fresh and sticky. However, after three weeks about half of these surface acorns had been destroyed and there was evidence that some of those planted had been dug up.

Damage to chestnut oak by animals is not, however, confined to seed destruction. Seedlings have been dug up, apparently for food still left in the acorn; tops have been bitten from some seedlings; others have been girdled. Animals are a real factor in the failure of chestnut oak, and doubtless other species, to establish themselves from seed in south Jersey.

Seedbed conditions and depth of sowing, chestnut oak.

Natural seedbed conditions, including depth to which acorns become covered by soil or litter, may be unfavorable to chestnut oak germination. All acorns which were planted under screen in the fall of 1929 on bare soil, without a cover of leaves, perished while germinating during the next few months. A planting depth of ½-inch, with a leaf cover, gave nearly complete germination; surface planting and planting at three inches both with a leaf cover, were much less satisfactory.

As a follow-up of the 1929 work, beds were planted in 1931 at depths of one, two, and three inches. Another bed was planted without preparing the soil; that is, the acorns were simply planted in dibble holes among the natural vegetation. It was desirable to have a bed of this nature because all other 1931 beds, including several yet to be described, were spaded and much of the competing vegetation removed.

A commercial mulch paper was used on some beds for comparison with the usual leaf mulch.

Seedling survival and development, chestnut oak

Observation during 1931 of seedlings from the 1928 and 1929 acorns on the Camp Ockanickon tract, and of a few scattered older seedlings on an adjacent area, revealed that injuries to both root and top are very common. That is, the original tap root is destroyed, which causes either laterals or a new tap root to form; and the top dies back, or is bitten off, but is replaced by a sprout from the root collar. These injuries were unquestionably fatal to many seedlings.

In the 1928 natural germination plot the number of seedlings left by the fall of 1929 was only three. During the summer of 1930 one of these died. The remaining two seedlings survived the winter and were still alive in September, 1931. Height growth on both these seedlings was extremely small, however. The trenched and untrenched seedlings from acorns germinating near the headquarters cabin in 1928 were again examined in 1931. Only three of the 12 untrenched seedlings and two of the 16 trenched seedlings developed normally in 1931. All others either had their tops bitten off or died back to the ground. Any effects of trenching - the object of which was to reduce competition from the roots of other vegetation - were obscured by this loss of the tops. Both groups had the same mean height at the end of the 1931 season although the seasonal growth was a little greater in the trenched group. The mean height of both groups was less than at the end of the 1930 season.

The various lots of acorns planted in 1929 in screened beds were reexamined in the fall of 1931. For all lots combined the percentage of survival had fallen from 66 in 1930 to 54 in 1931. Many of these acorns had also suffered the characteristic top injury, that is, the tops had died and the new growth originated from the root collar. This explains the irregularities and apparent discrepancies in the measurements shown in table 1.

Table 1

	Planted 1929 number	Alive autumn 1930 number	Alive autumn 1931 number	Survival 1930 per cent	Survival 1931 per cent	Mean height 1930 inches	Mean height 1931 inches	Mean growth, 1931
Bed 1 - ½" deep	78	72	69	92	88	3.28	3.28	.66
Bed 2 - 3" deep; acorns planted radicle down	42	9	6	21	14	2.36	3.58	1.21
Bed 2 - 3" deep; acorns planted radicle up	36	25	15	69	42	3.07	4.41	1.26
Bed 4 - on surface. Covered with leaves	78	32	28	41	36	3.22	3.49	.82

Those acorns planted deepest made the most growth in 1931.

In the summer of 1931 two of the seed beds were trenched, the trench being 1 foot wide and 3-4 feet deep. All roots entering the bed were cut off and the trench refilled.

The importance of soil moisture as a factor in determining the survival and satisfactory development of tree seedlings was emphasized during the summer of 1931. As in all previous studies, chestnut oak was principally, but not exclusively, investigated. Records of soil moisture content begun in 1930 were continued. Water holding capacities of the soil from several stations were determined at intervals, using the Hilgard copper pan method. Water content on two occasions was below the wilting coefficient, and was near it several times.

The root systems of about 30 oak seedlings were studied by removing them from the soil with a stream of water from a hand spray pump. These seedlings were photographed with the lateral roots placed about as they occurred in the soil. This study of roots has shown in what horizons the bulk of the absorptive system lies and what it must compete with in the way of root systems of other vegetation. Part of the root system of a white oak sprout, about eight inches in diameter, which had been cut in 1929, but had re-sprouted, was laboriously excavated with the spray pump. The investigators estimated that about half of the fine feeders, or absorbing roots, were dead. Whether they died when the bole and crown of the tree were removed, or would have died in the normal course of root expansion had there been no cutting, will have to be learned by examining the roots of undisturbed individuals.

Transpiration is important in any study of soil moisture. Moisture content of leaves from watered beds of 1930 chestnut oak seedlings was found to be 137 per cent, and from unwatered beds, 120 per cent. The leaves from the watered beds then had 14.4 per cent more than those from the unwatered beds. This test had been preceded by a long dry spell and the soil moisture in the unwatered bed was very low.

Clipping cobalt chloride paper over the leaves until the paper changed color due to transpired water, showed that the stomata were closed in the leaves in the dry bed while they were open in the wet bed leaves. Examination of the epidermis in the dry bed of seedlings was made microscopically, and the stomata were found closed for long periods.

Leaves from the same two beds were tested for stored food in the form of starch. At the end of the dry period, leaves from the dry bed contained no starch, while starch was abundant in leaves from the watered bed.

Although soil moisture appeared likely to be the critical factor in seedling survival and development, other factors were not overlooked: soil acidity, hardening of tissue, and light.

Tests of the soils at Camp Ockanickon during 1931 showed them to be uniformly acid. This was expected, because most Coastal Plain soils are acid, but the high degree of acidity - as indicated by a pH of 4 to 5 - was a surprise. Because European forestry literature refers to oak as a genus not prospering on acid soils, a study was begun of oak seedlings growing in soils rendered less acid by liming.

During the summer three seed beds, five by eight feet, were made. One was treated with ground limestone at the rate of three tons per acre, one at the rate of $1\frac{1}{2}$ tons per acre, and the third was untreated. The beds were spaded at intervals during the summer to work the lime into the soil. On September 23, 1931, the pH of the beds was as shown in table 2, determinations being made with the quinhydrone apparatus.

Table 2

Depth inches	Plot 4	Plot 5	Plot 6
	No lime	$1\frac{1}{2}$ tons per acre	3 tons per acre
2	4.19	5.54	5.79
6	4.27	5.91	5.46
12	4.66	5.75	5.71
18	4.38	5.57	5.40
24	4.74	5.57	5.57

On October 20, 153 acorns of several species were planted in each bed. Germination and seedling development will be carefully observed. Some seedlings will necessarily be removed to study root development, but the majority will be left for study through several growing seasons.

Three other seed beds were prepared by spading and removing all roots. One was treated with muriate of potash, KCl, at the rate of 200 pounds per acre, one at the rate of 100 pounds per acre, and the third was untreated. These beds were planted in October, 1931, each with 105 acorns of four different species. It is thought that the potash will result in the wood becoming harder during the growing season; winter-killing of tops (if death of tops be due to winter-killing) should be minimized.

Two beds were also planted with acorns in an experiment with light. During 1932 the seedlings in one will receive half light, and in the other full light.

Mensuration, oaks

(Assistant Silviculturist Schnur in charge)

Progress was made in the difficult analysis of the 1928 data concerning the solid contents of stacked cords, and an article covering the 1928 field work will be published in some form early in 1932.

Mr. Schnur spent about a month at the Pennsylvania State College, working with Professor A. C. McIntyre on volume tables of oaks and associated species in terms of mine props. Bulletin 269, entitled "The Measurement of Mine Props - Linear Foot, Top Diameter, Weight and Volume Tables," was published in September, 1931, by the College as a joint contribution from the Pennsylvania Agricultural Experiment Station and the Allegheny Station.

Mensuration, Coastal Plain

(Assistant Silviculturist Schnur in charge)

Loblolly pine, which originally occurred in mixture with hardwoods on the Eastern Shore of Maryland and in Delaware, today is found in pure stands on many abandoned fields, clear-cut areas, and burns.

In 1906 the Forest Service established on private land 59 permanent sample plots in various pure stands of loblolly pine on the Eastern Shore of Maryland. One series of 13 plots was located in stands of different densities of stocking in order to study the difference in development and rate of growth of thickly-stocked and open stands. Another series of 22 plots was established to study the effect of thinning on the growth and development of the stand. These plots were paired; one of each pair was thinned in 1906 and the other left intact as a check for comparative purposes.

Each tree was given a permanent number and carefully described. Enough tree heights (15 to 25) were measured to construct a height-diameter curve for each plot. The age and crown density of each plot were determined and a general description was written. At 5-year intervals since 1906 the plots have been re-measured by either the Maryland Department of Forestry or the United States Forest Service. Cutting of the trees by their owners has, however, gradually reduced the number of usable plots. By 1930 there were but 24 of the original 59 plots left.

A total of 212 individual plot measurements and re-measurements are now available for analysis, including a study of the diameter distributions of all intact plots to determine the characteristics of natural stands, and how these characteristics change during the life of a stand. Plots of different ages and degrees of stocking will be compared. Diameter distribution will be studied in the thinned plots also and comparisons will be made between thinned and unthinned plots. From these analyses some concrete idea may be gained of the most desirable diameter distributions to have at different ages, and how to bring these about.

Forestation, planting

(Assistant Silviculturist Wood in charge)

In April, 1931, the following pine seedlings were planted at Camp Ockanickon in openings among nine-year old Coastal Plain sprout hardwoods: 1010 Norway, 348 shortleaf, 554 pitch, and 424 loblolly (New Jersey stock), all two years old; also 1010 loblolly (Maryland stock), one year old. In the previous year 3409 Jack, Norway, pitch, shortleaf, and white pines had been planted under similar conditions.

No examinations were made until November, 1931. At this time, both the 1930 and 1931 plantations were examined by individual trees. In spite of the somewhat less favorable growing season in 1931, the first-year survival of the trees planted in 1931 was somewhat greater than in 1930. Norway pine showed the lowest

survival percentage in 1931, and the highest in 1930. This is probably due to a poorer class of planting stock more than to any other factor. Survival of pitch pine at the end of the first growing season was almost the same in 1931 as in 1930. The 1931 shortleaf had a somewhat higher survival percentage, largely perhaps because only the most promising seedlings in each bundle of stock were planted. For the 1930 trees the present death rate is lowest in the two native pines, pitch and shortleaf.

There is a fairly constant relation between growth in both years and the size of the stock when planted, although this relation is less marked in the 1931 plantation. The species with highest survival percentage do not have the greatest mean growth. To correlate these two indicators of success a figure called the "establishment index" has been computed. For each species the number of trees surviving for every 100 planted (survival percentage) has been multiplied by the 1931 mean growth figure. The species having the greatest resulting product is rated as 100, and all others as fractions of this. These indices are shown in table 3.

Table 3

1930 plantation		1931 plantation	
Species	Index	Species	Index
Shortleaf pine	45	Shortleaf pine	58
Red pine	100	Red pine	31
Pitch pine	99	Pitch pine	89
White pine	41	N.J. loblolly	57
Jack pine	55	Md. loblolly	100

Protection, fire

(Unassigned)

In June, 1930, Mr. Wood, with the assistance of Mr. Eyre of the Washington office, laid out eleven plots to study the damage caused to pine and hardwood stands in south Jersey by fires during the severe spring fire season of that year. Five of these plots were located on the Camp Ockanickon tract, two on the Lebanon State Forest, and four on the Bass River State Forest. They varied in size, and included as wide a variety of tree diameters, age classes, and species as possible. One of the eleven plots was an unburned check. The following data were recorded for each tree: d.b.h., species, extent of injury, and whether sprouting or not. Age and height of sample trees were also recorded. Injury was classified as light, medium, and severe; many trees were dead. At definite intervals, along a 10-link transect through each plot, the depth of litter and humus was measured.

Some office analyses of these data were made in the summer of 1930. Trees on each plot were grouped by diameter, injury class, and species. Table 4 shows the number of fire-killed trees by species and diameter classes. For trees above 16 inches d.b.h. the data are too meager to include. The high survival of shortleaf pine is partly due to the small number of 1 and 2-inch trees in the burned stands. If only those trees 3 inches in diameter and over are considered, survival percentages are as follows: shortleaf pine, 70; pitch pine, 59; white oak, 32; black oak, 30; chestnut oak, 13; and scarlet oak, 11.

Table 4

Total number of trees, number and per cent dead.

D.B.H.	White oak			Black oak			Scarlet oak			Chestnut oak			Pitch pine			Shortleaf pine			All species		
	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent	All trees (number)	Dead trees (number)	Dead trees per cent
1	49	48	98	5	5	100	14	14	100	5	5	100	128	128	100	1	1	100	223	222	99.6
2	61	46	75	11	10	91	15	15	100	5	5	100	139	139	100	-	-	-	240	221	92.1
3	167	114	68	38	20	53	111	111	100	31	28	90	53	37	70	3	3	100	413	321	78
4	85	66	78	12	11	92	76	73	96	37	35	95	22	9	41	9	6	67	244	202	83
5	54	39	72	6	6	100	44	40	91	18	16	89	24	9	38	14	4	29	160	114	71
6	41	28	68	2	2	100	30	23	77	4	3	75	24	9	38	13	2	15	114	67	59
7	16	7	44	2	2	100	14	6	43	6	3	50	26	7	27	11	2	18	75	27	36
8	13	8	61	1	1	100	15	12	80	1	1	100	18	3	17	6	1	17	54	26	48
9	6	3	50	-	-	-	2	-	-	1	-	-	10	3	30	9	3	35	28	9	32
10	4	4	100	-	-	-	4	2	50	1	-	-	12	3	25	4	-	-	25	9	36
11	1	1	100	-	-	-	2	-	-	-	-	-	8	3	38	1	-	-	12	4	33
12	-	-	-	-	-	-	-	-	-	-	-	-	6	1	17	-	-	-	6	1	17
13	3	1	33	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	6	1	17
14	4	3	75	2	2	100	-	-	-	-	-	-	-	-	-	-	-	-	6	5	83
15	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
16	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	-	-
Totals	509	363	72	79	59	75	328	296	90	109	96	88	475	351	74	71	22	31	1612	1229	76
Survival percentages			28			25			10			12			26			69			24

Note: 1 and 2-inch trees tallied on .5116 acres, 3 to 20-inch trees on 3.8 acres.

Types

(Unassigned)

Mr. Hough's article, on diameter distribution as an indicator of age conditions in white pine stands, particularly virgin stands, has been strengthened by the inclusion of all the data now in the Station's possession, and is in final form for publication.

Mr. Morey completed his analysis of the age and height data for the Hearts Content virgin white pine forest. Unquestionably the experience gained in the reconstruction of the forest history at Hearts Content will be invaluable in future study of the virgin timber on Tionesta Creek. The latter study, although in reality a type study, will fall easily into the project: "Management of Allegheny hardwoods."

The Director's labors on the type committee of the Society of American Foresters were completed in December, when the committee's report was received for publication by the Society. The type committee of the Allegheny Section, of which Mr. Hough is a member, concerned itself chiefly with a study of the effect on forest composition of the severe 1930 drought.

RESEARCH IN FOREST PATHOLOGY *

The work for the Branch Office of Forest Pathology at the Allegheny Forest Experiment Station for the past year was directed along the following lines: 1, butt rot of sprout hardwoods resulting from causes independent of fire; 2, a general disease survey; and 3, diseases of forest nurseries. Studies on the decay of sprout hardwoods project consisted primarily of a preliminary survey for the purpose of locating suitable cutover areas for temporary plots. By suitable areas are meant those where the recently cut stands of timber had not suffered from visible fire damage. A number of such plots were located in northern New Jersey, southwestern Pennsylvania, and western Maryland.

Data forms were prepared and preliminary stump measurements were made on the following plots: 1, improvement cuttings at Laurel Summit near Ligonier, Pennsylvania; 2, the windthrow on the Vorhees State Park at High Bridge, New Jersey; and 3, a private cutting operation at Split Rock, New Jersey. On the foregoing plots, a number of sprout stumps which showed decay were thoroughly dissected

*Prepared by Mr. Jackson. Dr. Doak's work on mycorrhiza project described under that heading in preceding section.

and the following points were noted: 1, the formation and anatomy of heart wood and its relation to the base of the stump; 2, the relation of the old parent stump to the new sprout stumps; and 3, decay and its relation to the old parent stump and the heart wood of the new sprout. The other data recorded were diameter outside and inside bark, heart wood, sap wood, decay, and the total number of rings as well as number of rings of sap wood and heart wood. Both internal and external scars and signs of decay were noted.

In addition to the recorded field data, considerable information pertaining to the private logging operations in the region was obtained. It is proposed that during the ensuing field season that a full study be made of all the plots which were located during the past season and any new cutting operations which happen to be located.

The work on diseases in forest nurseries has been along two distinct lines. The general field work has consisted merely of answering inquiries from nurseries both in and outside the region. A certain amount of cooperative work has been carried on with a few nurseries within the region. The other phase of the nursery project has been the laboratory studies on the relationship between H-ion and the Al-ion and damping off of certain coniferous seedlings, caused by strains of Pythium and Rhizoctonia. These experiments have been carried on in both liquid and quartz sand cultures. A nutrient solution which will not precipitate at any pH in the presence of either aluminum or iron has been developed and used successfully. This solution has been checked from the growth standpoint with a standard nutrient solution or rather a modified Shives system, and no appreciable difference was found in the growth of the seedlings. The solution differs from all other plant nutrient solutions which have been used heretofore in that the nutrient elements are soluble about pH 6.0 and furthermore that aluminum sulphate can be kept in a solution in soluble form within that pH range. The fungi have been studied in the same nutrient solution and their respective pH limits determined. Data were also reported to show the relationship between pH and growth of coniferous seedlings. This material is now being prepared and will be submitted for publication very shortly.

The general disease survey project has not been developed very extensively but at present we have records for a fairly large number of forest tree diseases in the Allegheny region. During the past field seasons an effort was made to make contact with the various forestry agencies for the purpose of obtaining information regarding tree diseases in their respective areas. Specimens have been collected, many of them photographed, and a few have been cultured. A permanent index system is being established at this Station for the purpose of recording all of the general forest tree diseases and their distribution within the region. The following list contains a few of the more important diseases which have been

found: 1, a wide-spread canker on yellow birch in Potter County, Pennsylvania, which was reported by Mr. Knull of Mont Alto; 2, a brown bark lesion disease on the trunks of white pine, collected at Fort Washington, Maryland, and northward through Pennsylvania as far as Petersburg, Pennsylvania; 3, a wilt of Ailanthus in the Philadelphia region; and 4, severe oak dying in Pike County, Pennsylvania. A case of oak dying was investigated in Garrett County, Maryland, and numerous other minor diseases such as needle rust of Scotch pine, twig blight of Austrian pine and others too numerous to mention in this report.

A large number of inquiries on forest pathology questions have been received and answered from both within and outside the region. During the ensuing year an effort will be made to collect more specimens and gather more information on general diseases of forest trees within the region and additional notes on the occurrence and distribution of those already recorded.

II. Plan of Work, January 1, 1932 to June 30, 1933

ADMINISTRATION

Branch Stations

The major effort in the development of branch stations will of course be made at the new Kane Branch Station. A permanent local superintendent will be obtained by transfer within the Forest Service. His presence will make it possible to undertake at once an intensive study of meteorological conditions in the forest; as much equipment as possible will be obtained from the Weather Bureau, and the rest purchased. The inventory of the stand will be pushed.

Projected branches. As stated in previous reports, it does not seem worth while to push the establishment of additional branch stations until funds are in sight for resident superintendents. Possible locations for additional branch stations will, however, be kept in mind throughout the coming year.

When funds are available for an erosion-streamflow study on the eastern seaboard the work should by all means be concentrated at one point, which will then become a branch station. Fortunately, it appears that the geological formation, and presumably the soils, are identical on the proposed joint municipal watershed in northern New Jersey, on the small watersheds likely in the future to supply the northwestern suburbs of Philadelphia, on the present Wilmington watershed, and on the present and proposed watersheds of Baltimore. Results obtained from research on any of these watersheds would be roughly applicable to all.

Natural Areas

East Tionesta Creek. The Station's efforts to have the Federal government purchase a lot of 250 acres in the virgin forest on East Tionesta Creek within the Allegheny National Forest have been futile. The Pennsylvania Forestry Association, however, has decided to work for the purchase of this land through private or corporate subscription, and for its transfer to the Federal government for scientific purposes. The Forest Supervisor is cooperating actively with the committee.

A plan to have Hearts Content designated as a natural area, subject of course to carefully limited recreational use of the central 20 acres, is being worked out.

Revision of list of forest research projects

The last list of forest research projects in the Allegheny territory was drawn up in 1927 by a committee of the Allegheny Section, Society of American Foresters, and is now obviously out of date. The Advisory Council at its last meeting recommended that the Station undertake to bring this list up to date, in cooperation with the various agencies represented on the Council.

SILVICS

Reduction of the permanent staff by one man during 1931 has made it more than ever imperative that the Station concentrate its efforts on a few lines of work. Only by so doing may we expect to keep office analysis and records of progress abreast of field work. Nevertheless, to the major projects now current - management of Allegheny hardwoods; protection, mycorrhiza; management, Coastal Plain; and mensuration, Coastal Plain - it seems desirable to add, or rather restore, a fifth major project: mensuration, oaks. Analysis of the loblolly pine growth and yield data should be completed, and the conclusions put in shape for publication, by autumn. Because of its interest in the Allegheny hardwoods type, and the lack of board foot yield tables for this type, the Station had planned as its next mensurational project a yield study of Allegheny hardwoods. However, the resignation of Director McCarthy of the Central States Station removes from the Forest Service the leader for the oak project, on which there is still a great deal of work to be done. For a number of reasons it is logical that the Allegheny Station, through Mr. Schnur, assume the responsibility for this project. In order to carry this assignment satisfactorily, it will be necessary for Mr. Schnur to continue his detail to Washington, probably through the fiscal year 1933.

The three minor projects on the Station program - forestation, planting; types; and protection, fire - will be continued, but with the exception of the first will become largely paper projects.

Additional details as to the work planned on each project appear below. It will be noticed that in every case the work planned for the next 18 months follows lines already opened, and assignments will be the same.

Management of Allegheny hardwoods.

Every effort will be made to start work on a sample plot program on the Kane Experimental Forest, after completion of the inventory.

The five-year remeasurement of the standing trees on the Little Arnot plots will be made at the end of the 1932 growing season, or before growth starts the next spring. These data, together with the even more important information on the reproduction which has succeeded the three different methods of cutting on these plots, should furnish material for a worthwhile progress report.

Further studies in the virgin timber on East Tionesta Creek will be delayed until 1933, unless further extensive logging is imminent. The experience gained in the study of the virgin timber at Hearts Content will eventually be applied in laying out sample plots in portions subject to cutting. These plots will not be located mechanically, but in various conditions which seem likely to be significant in interpreting the past history and probable succession of this virgin timber. Completion of the study, that is, analyzing the stumps and examining them for fire scars and similar injuries, will have to await logging.

Director Forbes plans to spend all his available time this spring in further examination of the 1929 extensive survey data, and collaborate with Mr. Hough in a paper on the composition of the beech-birch-maple type in Pennsylvania. Some data will be included on the effect of different degrees of cutting on composition of both virgin and second-growth stands.

Protection, mycorrhiza.

The sub-projects to which Mr. Hatch will devote himself are as follows:

Sub-project 1. The pure culture experiment at the Boyce Thompson Institute for Plant Research will be continued with the following alterations in technique: instead of using units of four chambers, supplied with one nutrient source and one air filter, individual units possessing one filter and one nutrient source per plant chamber will be employed; aeration will be accomplished by forcing filtered air through the chambers rather than by sucking filtered air through them; the seed used will be after-ripened and germinated individually on agar slants rather than on agar Petri dishes in groups of 10.

A technique similar in all other respects to that used in the initial experiment will be followed. Because of lack of time, only 20 chambers will be used and all of these will be employed in one experiment. This experiment is designed to elucidate whether or not mycorrhiza fungi are of benefit to tree growth by virtue of symbiosis rather than as a soil organism capable of converting nucleic acid into ammonia. The theory of this work is as follows. In many raw

humus soils of cool climates virtually no mobilization of nitrogen in forms available to the growth of autotrophic trees occurs. The only nitrogen is in extremely complex organic forms. Soil fungi are capable of decomposing this organic matter and liberating ammonia. In raw humus soils, however, the amount of nitrogen in proportion to carbon is such that every bit of the ammonia so liberated is immediately utilized by the fungi causing its liberation, in the synthesis and metabolism of their own cells. From theoretical considerations, therefore, the only means by which trees may continue to exist in raw humus soils is by obtaining their nitrogen through a symbiotic relation with soil fungi in the act of breaking down complex nitrogen sources. Dr. Melin, in Sweden, attempted to prove this relation in pure culture. He used nucleic acid as the complex source of nitrogen and grew cultures of pine and spruce for three years in Erlenmeyer flasks with and without the presence of mycorrhiza fungi. The results expected were actually obtained, that is, the trees supplied with mycorrhiza fungi grew normally while those lacking the fungi exhibited nitrogen starvation characteristics. The significance of these results however was questionable because several contaminations by non-symbiotic fungi in his check cultures produced identical results. These fungi easily utilized the nucleic acid and so liberated ammonia, which in turn was immediately utilized by the seedlings.

The special pure culture apparatus at the Boyce Thompson Institute was designed so that nutrients could be added or removed at will. Consequently it is possible accurately to control the carbon-nitrogen ratio of the nutrients and thus set up in pure culture conditions comparable in this respect to those in raw humus, for example. Several non-symbiotic soil fungi therefore will be deliberately introduced into six of the chambers and inasmuch as they will utilize all of the ammonia that they liberate, in the process of decomposing the nucleic acid, the seedlings will still be dependent on a symbiotic fungus for their nitrogen. Consequently it should be expected, assuming the theory to be correct, that the check plants and those inoculated with soil fungi will all show nitrogen starvation. The seedlings with the symbiotic fungi on the other hand should grow normally. If these results were obtained they would substantiate the remarkable claims that have been made regarding the impossibility of autotrophic tree growth in many soils.

The seedlings in this test will be grown for about eight months, or from February to September. Measurement and chemical analysis of the seedlings will easily require the remainder of the calendar year. Should Hatch carry out a plan for one year's additional graduate study, beginning in the fall, he would probably use this material for his thesis.

Sub-project II. Completion of analyses (photographing, histology mostly) of the pure culture syntheses of some 24 fungi on white and red pine carried out by Mr. Hatch in Dr. Melin's mycological

laboratory in Stockholm, Sweden. Positive results were obtained with eleven species of fungi on white pine, and some of these mycorrhiza are considered by Drs. Melin and Rayner to be the best that have so far been produced in pure culture. It is desirable that this material be cleaned up and be published upon before the syntheses now in progress in connection with the field survey require similar attention.

Sub-project III. Analyses (macroscopic examination, photographing, histology) of root systems of white pine seedlings from American seed grown in five Swedish soils and under five light intensities at the Government Forest Experiment Station in Sweden. Dr. Rayner recommends that in planting trees in a new region humus from native stands of the species in question should be used to inoculate seed beds in the new locality in order to obtain vigorous growth. Since the white pine seedlings grown in the five Swedish soils actually responded more strongly to the local mycorrhiza flora than did the native species used, this somewhat contradictory information should be put on record as early as possible.

Dr. Doak has set up the following objectives for his work during 1932 and subsequently: to determine the relationship of mycorrhizal fungi to host roots in the ectotrophic and endotrophic mycorrhiza occurring in the region; to establish the identity of suspected mycorrhizal fungi by inoculation of seedling trees in pure culture; to develop suitable methods for studying in a critical manner the effects of mycorrhiza on growth of trees; to determine the effect of mycorrhiza on growth with various sources of nitrogen; to determine the effect of mycorrhiza on growth under various levels of mineral nutrition; and to establish the relationship of host and fungus in mycorrhiza produced in pure cultures to those collected in stands, nurseries, and plantations.

Early in 1932 he plans to test the capacity of the 35 or more fungi collected during the field survey of 1931 to form mycorrhiza on forest trees. They will be placed with seedlings of Pinus strobus, P. taeda, P. resinosa, P. rigida, and Picea abies, growing in sterile chambers in the greenhouse. Fungi which prove from this series of experiments to be able to form mycorrhiza will be used in future growth studies, using as hosts both hardwoods and coniferous species of trees. The method of handling these syntheses was developed after a series of preliminary experiments with various types of chambers, sand cultures, and nutrient solutions, and with methods for sterilizing and germinating seeds. An early study will be undertaken to compare the action of two fungi (Boletus granulatus and B. bicolor) on Pinus rigida in sterile cultures with organic and inorganic sources of nitrogen.

Dr. Doak also plans to continue the collection of mycorrhiza-forming fungi, but from more restricted areas and in a more intensive fashion than during 1931. The branch stations naturally suggest themselves as places for intensive study over a period of years. One object will be to determine the time of formation and the longevity of mycorrhiza on various species in relation to occurrence of sporophores of suspected fungi.

In all cases where evidence has been convincing that the fungus obtained in pure culture is mycorrhiza-forming, synthesis experiments to serve as final proof will be started at once in the greenhouse. Many of these require five to six months for completion and can be progressing at any season along with other phases of the investigation.

Management, Coastal Plain. The work of 1931 will be followed up and expanded. Mr. Wood hopes that the acorns sown during the fall of 1931 will give him sufficient material to allow of a much more thorough study of various factors affecting natural reproduction than was possible during the previous year, when the number of seedlings was very limited. Dr. Yocum, now at George Washington University, expects during the winter to check the wilting coefficient of certain soil samples, as determined last summer by the Hilgard method. Wood will continue to observe the seedlings free of root competition by trenching; certain of the seedbeds will again be artificially watered, beginning in May if possible. Studies of water loss through transpiration will be continued by the cobalt chloride paper and possibly other methods. The root systems of additional seedlings and larger trees will be excavated, and the general physiology of roots will be studied. Observations will of course be continued of seedlings in the beds where acidity has been artificially changed.

Mensuration, Coastal Plain. In addition to his work on diameter distribution in the loblolly pine plots, Mr. Schnur will analyse and summarize the material on total cubic volume, average yearly growth, mortality as related to diameter, and the effect of thinning. The yield obtained from these plots will be compared with that shown for the same site by the southern pine yield tables, and whatever correction factors are necessary to apply the regional yield tables to Maryland conditions will be worked out. One or more manuscripts reporting on these matters will be prepared.

Mensuration, oaks. Construction of the yield tables for pure and mixed stands will be the first job, and is likely to last through the fiscal year 1933. Plans will meanwhile be considered for establishing a series of permanent yield plots in the oak type, if possible throughout the Station territory.

Forestation, planting. Field work will consist of planting about a thousand pine seedlings at Camp Ockanickon as replacements, and about two thousand in adjacent areas not hitherto planted. This is a considerably smaller program of planting than in previous years, and should complete the planting of all land where inter-planting is likely to succeed.

PATHOLOGY

Work will be continued by Mr. Jackson on his three current projects. The Advisory Council at its last meeting recommended that in view of the evident impossibility of one man's carrying three projects satisfactorily, he concentrate his efforts on the study of rot in oak sprouts.

Dr. Doak's plans are incorporated in the previous section, "Silvics", under the mycorrhiza project heading.

III. Manuscripts

Published, 1931

Six articles by R. D. Forbes, H. F. Morey, and O. M. Wood in Service Bulletin.

A test of hypsometers on short trees. H. F. Morey, Journal of Forestry, February, 1931.

Climatological charts for the Allegheny Forest Region. H. F. Morey, Monthly Weather Review, January, 1931.

Large yellow poplar killed by porcupines. H. F. Morey, American Forests, October, 1931.

Tags and painted numbers on trees in permanent sample plots, H. F. Morey, Journal of Forestry, May, 1931.

The measurement of mine props, linear foot, top diameter, weight and volume tables. G. L. Schnur, in cooperation with A. C. McIntyre. Pennsylvania State College Bulletin 269, September, 1931.

Watershed cover and water conservation. R. D. Forbes. Proceedings of the Maryland and Delaware Water and Sewerage Association, May, 1931.

Submitted, 1931

An example of white pine reproduction on burned lands in northeastern Pennsylvania. O. M. Wood, Journal of Forestry.

Diameter distribution in forest stands in northwestern Pennsylvania. A. F. Hough, Journal of Forestry.

Inaccuracy of seedling analysis in the field. H. F. Morey. Journal of Forestry.

What is the growth per cent of American forests? H. F. Morey, Journal of Forestry.

Proposed
January 1, 1932, to June 30, 1933.

Progress report on studies of reproduction following cutting in Allegheny hardwoods. Hough, Journal of Forestry.

The composition of the beech-birch-maple type in Pennsylvania. Forbes and Hough. Journal of Agricultural Research.

Synthetic production of mycorrhiza on white and red pines. Hatch. Journal of Agricultural Research.

Mycorrhiza formation on American white pine in Swedish soils. Hatch. Journal of Agricultural Research.

Progress report on natural reproduction of chestnut oak in southern New Jersey. Wood. Departmental Yearbook.

The progress of diameter distribution in empirical stands of loblolly pine. Schnur. Journal of Agricultural Research.

Local volume tables for loblolly pine in Maryland. Schnur. Mimeographed.

Progress report on experimental thinnings of loblolly pine. Schnur. Journal of Forestry.

Soil types as reflected in forest composition in southern New Jersey. L. L. Lee (New Jersey Agricultural Experiment Station) and Wood. Journal of Agricultural Research.

A comparison of two samples of virgin white pine timber in northwestern Pennsylvania. Morey. Journal of Botany.

Further notes on the vegetation of Hearts Content. Morey. Ecology.

A compiled list of forest research projects current in the states of Delaware, Maryland, New Jersey, and Pennsylvania. Forbes. Mimeographed.

EXPENDITURES, CALENDAR YEAR 1931
(Silvical Investigations)

BY BUDGET ITEMS

Salaries permanent	$21,462.16
" temporary	2,230.12
Travel	2,154.10
Supplies and equipment	3,639.80
Rent, heat, light, etc	241.34
Freight, express, and hauling	128.81
*Improvements	420.26
Maintenance of passenger-carrying vehicles	435.63
Miscellaneous	132.96
	$30,845.18

BY PROJECTS

Forestation (Planting)	$ 1,296.84
Influences	54.82
Management, Allegheny Hardwoods	9,984.62
Management, Coastal Plain	4,485.33
Mensuration, Oaks	3,170.31
Mensuration, Loblolly Pine	4,312.28
Protection	
Fire (General)	116.62
(Mycorrhiza)	6,304.35
Types	1,120.01
	$30,845.18

*Other improvements under special appropriation $16,000.00

V. Station needs

Last year the Station recommended an early beginning on two new projects of major importance, and adequate expansion of a third project on which a very small amount of work had previously been done. These projects are:

1. A study of the influence of forests and other vegetation on streamflow for domestic and commercial use.

2. A study of methods of appraising the recreational values of the forest.

3. A study of fire damage (a minor project on the present program).

These recommendations were justified in detail in the previous annual report of the Station. The need for all three projects is as acute as ever.

Considerable time was given at the last meeting of the Advisory Council to Mr. Richards' proposals, based on 15 months' travel in central Europe, that the foresters frankly recognize that game management is an integral part of forest management, since the use of the forests for wood production and game are not naturally compatible. That is, there is a delicate balance which must be preserved between the forest and the wild life which inhabits it; the maximum of both wood and game can not be obtained on the same land at the same time. Methods of evaluating the wood are fairly well established, but there is more than ever need to undertake a study of the actual money values involved in game and recreation, (the second study in the above list).

The State of New Jersey has for some time planned an aerial survey of the forest resources of the state. Economy has of course forced the abandonment of this plan for the time being, but as soon as conditions improve, the plan will be revised, and will be made a basis for the Station's request for funds from the Forest Survey.

Previous reports have stated the arguments for the assignment to the Allegheny Station, by other bureaus of the Department, of at least one entomologist and at least one zoologist.